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REMARKS

Claims 6-11 and 14-27 remain in the application.

First, the Examiner is requested to withdraw the finality of the rejection. The only substantive rejection of Claim 6 in the prior Office Action was a double-patenting rejection, which was removed by a Terminal Disclaimer and not by restricting the coverage of the claim. The last response broadened Claim 6 over the originally filed form. A broadening of a claim may allow a new ground of rejection, but it does not necessitate a new ground of rejection, as required by MPEP §706.07(a), since a valid ground of rejection for a narrow claim applies equally well if not better to a broadened claim. Furthermore, newly added Claims 18 and 19 depending from Claim 6 reintroduce restrictions removed from the broadened Claim 6. Nonetheless, the Examiner feels compelled to develop a new grounds for rejection. Clearly, Applicant's amendments did not necessitate the new grounds of rejection. Accordingly, the Examiner is requested to withdraw the finality of the rejection and allow all amendments of right.

The Examiner has rejected Claims 6 and 7 under 35 U.S.C. §102(b) as being anticipated by JP 63-282263A (JP'263). Claim 6 has been amended to require that the outer pole has two straight portions connected by curved portions, for example, the racetrack of FIG. 4 and the triangles of FIGS. 9 and 10. The added restriction is consistent with the reasons presented by the Examiner for the allowance of Claim 21. The newly claimed shape is neither disclosed nor suggested by JP'262.

The Examiner has rejected Claims 8, 9, and 20 under 35 U.S.C. §103(a) as being obvious over JP'263 in view of Lai (U.S. Patent 5,593,551). These claims depend from claims now believed to be in allowable form so they also should be allowable.

The Examiner has rejected Claims 10, 19, and 20 under 35 U.S.C. §103(a) as being obvious over JP'623 in view of JP 10-152774 A (JP'774). Applicant believe the rejection of Claim 10 requires unpermitted hindsight in view of the lack of suggestion in JP'623 for the oval shape and that JP'623 and JP'774 teach different approaches for solving related problems so that there is no motivation for combining them. However, in view of the amendment to Claim 6,

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these claims depend from claims believed to now be in allowable form.

Additionally, Claim 19 requires that the metal ionization density be at least 20%. Although JP'774 teaches the advantages of high ionization, it discloses no ionization fraction. It is far from clear that the large magnetron of JP'774 is capable of such a high ionization fraction since the sputter power is distributed over such a large area of the target. Claim 19 has been further amended to require that the ionization density is achieved by the combination of DC target power and the size and magnet configuration of the magnetron. In contrast, JP'774 seems to imply (§0058) that additional ionization means be used, including the unpermitted inductive coupling. Accordingly, Claim 19 is additionally allowable.

The Examiner has rejected Claims 11, 12, and 14 under 35 U.S.C. §103(a) as being obvious over U.S. Patent 5,833,187 to Tsai in view of Musil et al. ("Unbalanced Magnetrons ...", hereafter Musil) and JP '774. Claim 11 has been amended to incorporate the restriction of Claim 13. Accordingly, this rejection is now moot.

The Examiner has rejected Claim 13 under 35 U.S.C. §103(a) as being obvious over Tsai in view of Musil and JP'774 and further in view of U.S. Patent 5,599,739. This rejection is traversed. Tsai and Musil are the only two references directed to an integrated tungsten fill process. Both references teach rapid thermal annealing (RTA) between the barrier deposition and the tungsten fill (Tsai, col. 4, ll. 24-32; Merchant, col. 3, ll. 38-57). Tsai teaches the advantage of a siliciding the barrier. Merchant teaches the advantage of curing pinhole defects and reducing volcano growth. The Examiner's dismissal of these teachings is traversed. Whether Tsai explicitly states that the RTA is critical does not overcome his clear teaching of the advantage of including RTA. The Examiner concludes without support in the applied art that the RTA is an optional step. However, neither Tsai nor Merchant teaches the optionality, contrary to the Examiner's position. The Examiner further states that the present specification does not teach the criticality of the lack of RTA. This statement does not bear on the obviousness of the limitation. The specification clearly teaches that, with the claimed barrier deposition process, RTA is not required to eliminate volcanos, contrary to the teaching of Merchant. Eliminating a

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step, even if the elimination is not critical, is advantageous and thus useful because equipment costs and processing time are reduced. The teachings of Tsai and Merchant for including RTA are *prima facie* proof that the restriction of Claim 13 that there be no RTA are contrary to and thus non-obvious over the prior art.

The Examiner has rejected Claim 15 under 35 U.S.C. §103(a) as being obvious over Tsai in view of Musil and JP'774 and further in view of U.S. Patent 4,717,462 to Homma. This rejection is traversed since none of the art discloses sputtering tungsten for a tungsten via and the aluminum art of Homma is not clearly relevant. However, this claim also depends upon a claim believed to be in allowable form and therefore should also be allowable.

The Examiner has rejected Claim 16 under 35 U.S.C. §103(a) as being obvious over Tsai in view of Musil and JP'774 and further in view of U.S. Patent 5,593,551 to Lai. This rejection is traversed. Lai fails to disclose the use of sputtering for a tungsten fill process, a particularly difficult geometry. Further, this claim depends upon a claim believed to be in allowable form and therefore also should be allowable.

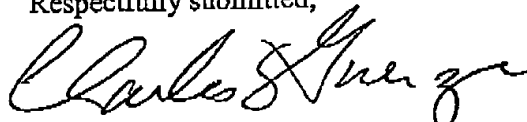
The Examiner has allowed Claims 21-26. The Examiner has also indicated that Claim 17 would be allowed if rewritten in independent form. It has been so rewritten. A new dependent Claim 27 recites what the Examiner states is excluded from the asymmetric target.

The amendments are additionally offered under 37 CFR 1.116 as canceling claims.

In view of the above amendments and remarks, reconsideration and allowance of all claims are respectfully requested. If the Examiner believes that a telephone interview would be helpful, he is invited to contact the undersigned attorney at the listed telephone number, which is on California time.

Date: 20 November 2002
Correspondence Address
Patent/Legal Dept.; M/S 2061
Applied Materials, Inc.
P.O. Box 450A
Santa Clara, CA 95052

Respectfully submitted,


Charles S. Guenger
Registration No. 30,640
(650) 566-8040

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Version with markings to show changes madeReplace the claims with:

6. (Twice Amended) A method of sputtering a material from a target comprising a metal onto a working substrate supported on a pedestal in a system including a magnetron disposed on a side of said target opposite said pedestal and including an outer pole of one magnetic polarity and surrounding an inner pole of another magnetic polarity, wherein said outer pole extends from a center of said target to a peripheral portion of said target and has an area smaller than a similarly extending circle and includes two straight portions connected by curved portions, said method comprising:

rotating said magnetron about said center of said target to achieve full sputtering coverage of said target; and

capacitively coupling power into said chamber at least partially by applying DC power to said target but not including inductively coupling power into said chamber to thereby excite said working gas into a plasma to sputter said metal from said target onto said working substrate.

11. (Thrice Amended) A tungsten fill process, comprising the steps of:

placing a substrate containing a hole formed in a dielectric layer in a magnetron sputter reactor including a titanium target and a magnetron comprising an inner pole of a first magnetic polarity and producing a first total magnetic flux and an outer pole of an opposite second magnetic polarity, producing a second total magnetic flux at least 1.5 times said first magnetic flux, and surrounding said first magnetic pole; in said magnetron sputter reactor, sputtering a barrier layer of titanium and titanium nitride into said hole while rotating said magnetron about a center of said titanium target; and

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thereafter filling tungsten into said hole of said substrate;
wherein there is no annealing step between said sputtering and filling steps.

Please cancel Claims 12 and 13.

17. (Amended) [The process of Claim 16,] A tungsten fill process, comprising the steps of:
placing a substrate containing a hole formed in a dielectric layer in a magnetron sputter reactor including a titanium target and a magnetron comprising an inner pole of a first magnetic polarity and producing a first total magnetic flux and an outer pole of an opposite second magnetic polarity, producing a second total magnetic flux at least 1.5 times said first magnetic flux, and surrounding said first magnetic pole;
in said magnetron sputter reactor, sputtering a barrier layer of titanium and titanium nitride into said hole while rotating said magnetron in back of and about a center of said titanium target, wherein said magnetron is asymmetric about an axis about which said magnetron is rotated; and
thereafter filling tungsten into said hole of said substrate.

19. (Amended) The method of Claim 6, wherein an amount of said DC power in combination with a size and magnetic strength of said inner and outer poles is sufficient to achieve an ionization density of said metal of at least 20%.

Please add the following new claim:

27. (New) The method of Claim 21, wherein said outer pole is neither circular nor oval shaped about an axis offset from said center of said target.

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